POLICY FOR THE CONTROL OF HAZARDOUS
AIR POLLUTANT EMISSIONS IN NORTH DAKOTA
(Air Toxics Policy)

PURPOSE

This document establishes the policy to be used by the North Dakota Department of Health, Division of Air Quality, for the evaluation of permit applications from sources emitting Hazardous Air Pollutants (HAP's) into the ambient air. This policy document is effective until modified by the Department or until formal rules are promulgated.

APPLICABILITY

This document is applicable to all new or modified air contaminant sources, as designated in 33-15-14-01 of the North Dakota Air Pollution Control Rules, required to submit an application for a Permit to Construct under Section 02 of Chapter 33-15-14. The Department may exempt the following source categories from the requirements of this policy: 1) sources of minor significance as determined by the Department and 2) any source subject to National Emission Standards for Hazardous Air Pollutants for Source Categories (MACT) which has demonstrated compliance with the residual risk provisions of the Clean Air Act.

Certain additional sources of HAP's will be considered for emission control by the Department on a case-by-case basis or as deemed appropriate. These may include "nontraditional" sources such as air strippers for the removal of organic contaminants from groundwater, ethylene oxide sterilizers, or any existing or new source where there is reason to believe that HAP's being emitted pose a significant risk to human health or the environment.

Sources affected by this document are required to complete an Air Pollution Permit Application (AP 100) if an application has not been submitted, a HAP Permit Application (AP-117), and submit any additional information needed by the Department to evaluate the potential risk to human health or the environment from HAP emissions.

AUTHORITY

The Department has authority to control HAP emissions under Section 33-15-02-04, subsection 3 of the North Dakota Air Pollution Control Rules which states, "The ambient air shall not contain air contaminants in concentrations that would be injurious to human health or well-being or unreasonably interfere with the enjoyment of property or that would injure plant or animal life. The Department may establish, on a case-by-case basis, specific limits of concentration for these contaminants."

DEFINITIONS
Hazardous Air Pollutant

For the purpose of this document, a hazardous air pollutant is defined as any air pollutant lacking an applicable AAQS which may contribute to a significant increase in human mortality, cause serious irreversible or incapacitating reversible illness, pose a significant threat to human health or the environment, or be considered by the Department of Health to pose a community problem. This definition is consistent with Section 33-15-02-04, subsection 03 of the North Dakota Air Pollution Control Rules and with Section 112 of the Federal Clean Air Act.

Best Available Control Technology (BACT) means an emission limitation (including a visible emission standard) based on the maximum degree of reduction of each contaminant emitted from or which results from any affected hazardous air pollutant source which the Department, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems and techniques including fuel cleaning or treatment or innovative fuel combustion techniques for control of such contaminant.

Lowest Achievable Emission Rate (LAER) means the most stringent emission limitation which is achieved in practice by such class or category of source, even if this involves "technology forcing" or "technology transfer" (U.S. EPA 1979).

Unit risk factor means an estimate of the probability of developing cancer when exposed to 1 ₣g/m^3 of a substance for 70 years.

Maximum individual carcinogenic risk means an estimate of the probability of developing cancer by an individual exposed to the greatest concentration of a substance in the ambient air over a 70-year period (U.S. EPA 1975). This is obtained by following the procedure outlined in the Dispersion Modeling Section of this document. For example, a maximum individual carcinogenic risk of

8 x 10^{-4} implies that eight people out of 10,000 would be expected to develop cancer when exposed for 70 years to the maximum concentration of a substance in the ambient air.

Aggregate cancer incidence means an estimate of the annual excess incidences of cancers within the entire exposed population (U.S. EPA 1985). This is obtained by multiplying the number of people exposed to each concentration of a substance predicted to occur in the ambient air, by the product of the predicted concentration and the unit risk factor.

BACKGROUND

The control of air pollutants has traditionally concentrated on a relatively few "criteria" pollutants, whose emissions are regulated by various local, state and federal rules. Particulate matter less than 10 microns in diameter (PM_{10}), sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead emissions are regulated by placing emission limits on designated air contaminant sources. The Federal NSPS program regulates, in addition to the previously mentioned pollutants, several air contaminants from select sources. Some effort has been made to control HAP's on the federal and state levels through the NESHAP and MACT programs. However, promulgation of new NESHAP's by EPA has been slow, requiring 4-5 years. Also, the NESHAP program has concentrated on pollutants posing a national health risk, not a local health risk. Small population centers are often overlooked in the federal process. The MACT program only addresses 188 pollutants and generally applies only to major sources of HAP's.

Increased local and national concern about the release of hazardous/toxic substances, the relative slowness of NESHAP promulgation at the federal level, the wide variety of chemicals released to the atmosphere and increased encouragement at the federal level, are the primary impetuses for a policy document delineating the Department's policy with respect to the control of routine releases of HAP's.

APPROACH

The approach used by the Department to evaluate permit applications for sources releasing HAP's into the ambient air is based upon classification of the HAP into one of three categories (discussed below), where each category represents the present certainty of a substance being a human carcinogen. Substances are classified as known human carcinogens, suspected or reasonably anticipated human carcinogens, and as noncarcinogens or substances lacking sufficient data to determine carcinogenicity. It is the Department's position that the classification of a substance as a known or suspected human carcinogen will be based on determinations made by either: (1) the International Agency for Research on Cancer (IARC); (2) the

National Toxicology Program (NTP); (3) the American Conference of Governmental Industrial Hygienists (ACGIH) or (4) the Environmental Protection Agency (EPA). These agencies are recognized experts in the disciplines of toxicology and carcinogenesis. Other substances not classified as a known or suspected human carcinogen by one of these agencies will be regulated by using adjustments to the Threshold Limit Value-Time Weighted Average (TLV-TWA), the Threshold Limit Value-Short Term Exposure Limit (TLV-STEL), or the Threshold Limit Value-Ceiling (TLV-C), as published by the ACGIH (1994). Additional pollutants not listed in the ACGIH handbook which pose a significant health risk, either directly or indirectly, will be evaluated on a case-by-case basis.

Group 1

Group 1 substances are substances known to cause an increase in the incidence of cancer in humans. Appendix A presents the list of substances classified by the Department as known human carcinogens. This list consists of those substances identified as confirmed human carcinogens in the ACGIH Handbook (ACGIH 2003), the substances classified as known carcinogens by the NTP (NTP 1985), human carcinogens (group A) by the EPA, and in IARC group 1. Because a causal relationship between the dose of Group 1 substances and the incidence of cancer in humans has been demonstrated, it is the philosophy of the Department that these substances pose a significant risk to human health. Therefore, the maximum individual carcinogenic risk due to emissions from an affected HAP source must be less than 1×10^{-6}. If it is the Department's opinion that sufficient data is not available to accurately estimate the maximum individual carcinogenic risk due to emissions from an affected HAP source, emissions of Group 1 substances from the source are subject to a Lowest Achievable Emission Rate (LAER) limitation.

Group 2

Group 2 substances are those reasonably anticipated to cause cancer (NTP 1985) or suspected of causing cancer in humans (ACGIH 2003). They are (1) substances classified as having limited evidence of human carcinogenicity based on evidence from human studies, but where alternative explanations such as chance, bias or confounding cannot be excluded; or (2) substances with sufficient evidence of carcinogenicity from studies in experimental animals which indicate an increased incidence of malignant tumors in: (a) multiple species or strains; (b) in multiple experiments (preferably using different routes of exposure and dose levels); (c) causing an unusual degree with regard to incidence, site or type of tumor or age at onset (NTP 1982). Group 2 includes substances (see Appendix B) in IARC group 1, ACGIH List A2, substances classified as reasonably anticipated carcinogens by the NTP or substances classified as probable human carcinogens (group B) by EPA.

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Therefore, the maximum individual carcinogenic risk due to emissions from an affected HAP source must be less than 1×10^{-6}. If it is the Department's opinion that sufficient data is not available to accurately estimate the maximum individual carcinogenic risk due to emissions from an affected HAP source, Best Available Control Technology (BACT) or Maximum Achievable Control Technology (MACT) (for new sources) must be applied to emissions of all Group 2 substances from the affected HAP source; whichever is more stringent.

Group 3

The policy for the control of Group 3 substances, substances which are not carcinogenic or for which there is insufficient data to establish evidence of carcinogenicity, is based on the use of the TLV-TWA, the TLV-STEL or the TLV-C developed by the American Conference of Governmental Industrial Hygienists (ACGIH 203). Substances designated by the ACGIH as simple asphyxiants such as helium whose mechanism of action is primarily through reduction of oxygen and which, upon dilution in ambient air should pose little health risk, are exempt. Those substances for which an ambient standard has been established in Section 33-15-02-04 of the North Dakota Air Pollution Control Rules have been removed from the list of Group 3 substances. In addition to those substances for which an ambient standard has been established, aluminum oxide, coal dust, grain dust and portland cement have also been removed from the list of Group 3 substances. These substances have been removed based on the Department's determination that the ambient standard for PM_{10} adequately addresses emissions of these substances.

The ACGIH (2003) defines the TLV-TWA as the time-weighted average concentration for a normal 8-hour workday and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The TLV-STEL is the concentration to which workers can be exposed to continuously for a short period of time without suffering from: (1) irritation; (2) chronic or irreversible tissue damage; or (3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency, and provided that the daily TLV-TWA is not exceeded. The TLV-C is the concentration that should not be exceeded during any part of the working exposure. Eight-hour and 1-hour Maximum Acceptable Ambient Levels (MAAL) for the pollutants specified in Appendix 3 are established from the TLV-TWA and TLV-STEL/TLV-C, respectively of the ACGIH. It must be stressed that the MAAL for a substance is not an ambient standard. Rather, the MAAL will be used by the Department as a mechanism to further evaluate the need for control of pollutant emissions from sources whose modeled concentrations exceed either the 8-hour or 1-hour MAAL. Also, only certain substances in Appendix 3 have a 1-hour MAAL. These substances have been recognized by the ACGIH as having acute effects as well as chronic effects and have an appropriate

TLV-STEL or TLV-C. Therefore, the Department believes an additional shorter averaging period is warranted for these substances.

Computation of both the 8-hour and 1-hour MAAL's are based on the application of certain correction factors to the TLV-TWA and TLV-STEL/TLV-C, respectively. Eight-hour MAAL's are calculated by first extrapolating the dose incurred during a 40-hour work week to an "equivalent" continuous weekly dose by dividing the TLV-TWA by 4.2 (168/40 hours). The TLV-TWA is then adjusted by dividing by a factor of 1.75 representing the average lung ventilation volume of 10 cubic meters/24 hours for a 6-year old child weighing 20 kg compared to the average ventilation volume of 20 cubic meters/24 hours for an adult weighing 70 kg (Commonwealth of Massachusetts 1985). This is done to protect children, whom for various reasons such as differing ventilation, absorption, and excretion rates, and immature immune systems, may be more susceptible to the effects of these pollutants. Finally, the TLV-TWA is divided by a safety factor of 10 to protect additional portions of the exposed population and provide additional safety. Therefore, the preliminary 8-hour MAAL is given by equation 1.

$$\text{Preliminary MAAL}_{8-hour} = \text{TLV-TWA} / (4.2 \times 10 \times 1.75) \qquad (1)$$

However, to simplify calculation of the MAAL and considering that divisors from 10 to 300 are presently used by a number of states depending on the toxicity of the substance being emitted, the safety factor was adjusted to 13.6, resulting in a divisor of 100. So, the MAAL of a HAP for an 8-hour averaging period based on the TLV-TWA is:

$$\text{MAAL}_{8-hour} = \text{TLV-TWA} / 100 \qquad (2)$$

The same divisor of 100 is applied to the TLV-STEL or TLV-C in calculating the 1-hour MAAL. This results in a very conservative 1-hour MAAL, which the Department believes is needed to prevent acute effects. Therefore the 1-hour MAAL, based on the TLV-STEL or TLV-C, is:

$$\text{MAAL}_{1-hour} = \text{TLV-STEL (or TLV-C)} / 100 \qquad (3)$$

When necessary, a MAAL will be set by the Department for those substances lacking an appropriate TLV. This will be done by applying the appropriate safety factors, determined to be necessary to prevent adverse health effects because of extrapolation from incomplete toxicity data or animal toxicity data, to the No Observable Effect Level (NOEL) or any other measure of toxicity, as deemed appropriate by the Department.

The AGGIH regularly updates the TLV-TWA and TLV-STEL for the various chemicals. The Department will use the latest version of

the ACGIH handbook to determine the appropriate MAAL. Should that data conflict with a MAAL listed in this policy, the most current TLV will be used for determining compliance.

DETERMINATION OF COMPLIANCE

To determine compliance with the applicable 8-hour MAAL, 1-hour MAAL or 1×10^{-6} risk criteria, the maximum off-property, ground-level ambient concentration of each HAP emitted from an affected HAP source must be calculated using the dispersion modeling procedure outlined in the following section entitled "Dispersion Modeling Procedure." For Group 3 HAP emissions, maximum 8-hour and 1-hour concentrations for each HAP must be calculated using the maximum potential HAP emission rate for that time period (i.e. 1-hour or 8-hour). For Group 1 and Group 2 HAP emissions, a maximum annual concentration for each Group 1 and Group 2 HAP and the maximum individual carcinogenic risk associated with emissions from the source must be calculated. When calculating a maximum annual concentration as part of a Tier 1 or Tier 2 analysis (as described in the Dispersion Modeling Procedure Section), the maximum potential annual average HAP emission rate must be used. The results of these calculations must then be used to determine if emissions from the affected HAP source comply with the MAAL(s), the hazard index or the 1×10^{-6} risk criteria established by this policy.

Facilities emitting more than one HAP will be given special consideration by the Department, because of the possibility of synergism between pollutants. For example, where two or more carcinogenic risk assessments are required, risks from the individual pollutants will be assumed to be additive and the combined maximum individual lifetime risk from all carcinogenic HAP's must be less than 1×10^{-6}. Similarly, the effects of multiple Group 3 substances emitted from a source are assumed to be additive, if the available toxicity data are insufficient to determine otherwise. The release of multiple Group 3 HAP's into the ambient air will be evaluated according to equation 4;

$$\text{Hazard Index} = \frac{MC_1}{MAAL_1} + \frac{MC_2}{MAAL_2} + \frac{MC_3}{MAAL_3} + \ldots + \frac{MC_n}{MAAL_n} \qquad (4)$$

where MC_1, MC_2, MC_n are the modeled ambient concentrations for HAP's 1, 2, ..., n and $MAAL_1$, $MAAL_2$, $MAAL_n$ are the Maximum Acceptable Ambient Levels for HAP's 1, 2, ..., n. A hazard index less than or equal to 1 will be considered acceptable, whereas a hazard index greater than one will trigger further review by the Department.

Certain affected HAP sources which emit Group 1 or Group 2 HAPs may be subject to a BACT or LAER emission limitation. The Department

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will determine BACT or LAER for these facilities on a case-by-case basis.

The Department may, on a case-by-case basis, require a number of approaches for those facilities unable to attain an estimated concentration less than the 8-hour or 1-hour MAAL, a hazard index less than or equal to one or a maximum individual carcinogenic risk less than 1×10^{-6}, after more refined modeling analyses are conducted. These approaches include, but are not limited to, application of LAER, BACT, or MACT (for new sources) to the source, ambient air monitoring or stack testing requirements, or modification of the source operating schedule.

DISPERSION MODELING PROCEDURE

A three-tiered approach to calculating the maximum off-property, ground-level ambient concentration of each HAP is recommended. The analysis begins with Tier 1, which is the simplest technique and involves the most conservative assumptions. Each successive tier involves more refined, less conservative techniques. If application of the Tier 1 procedure results in a maximum individual carcinogenic risk of less than 1×10^{-6} (Group 1 and 2 HAP's), a hazard index less than or equal to one, and compliance with the MAAL's (Group 3 HAP's), no further analysis is necessary. However, if the subject source does not meet the carcinogenic risk, MAAL's, or hazard index criteria after application of the Tier 1 procedure, a Tier 2 analysis will be necessary. Likewise, failure to comply after the Tier 2 procedure mandates a Tier 3 analysis.

The Tier 1 procedure involves the use of simple look-up tables to determine maximum off-property, ground-level ambient concentrations for each HAP with a minimum of source information. The Tier 2 procedure requires use of a computer and the EPA SCREEN3 model. Lastly, the Tier 3 procedure involves use of a refined computer model. Through use of detailed information on source and meteorological conditions, the Tier 3 procedure provides the most realistic (least conservative) HAP concentrations.

Tier 1 Procedure

The Tier 1 procedure utilizes look-up Tables 1 and 2, which provide normalized maximum 1-hr concentrations for various stack heights and downwind distances. Table 1 is used to determine HAP impacts from stacks which are good engineering practice (GEP) height with respect to all nearby buildings. Table 2 applies for stacks which are less than GEP height with respect to nearby buildings. In the latter case, maximum ground-level concentrations will generally be higher because of building downwash effects. GEP height, in the context of the present analysis, is defined as follows:

$$H_g = H + 1.5L \tag{5}$$

Where:

H_g = good engineering practice stack height, measured from the ground-level elevation at the base of the stack,

H = height of nearby structure, measured from the ground-level elevation at the base of the stack,

L = lesser dimension, height or projected width, of nearby structure.

"Nearby" is defined as less than 5L distance from the stack. If more than one nearby structure is present, GEP height should be based on the structure which produces the largest Hg in Equation 5.

The Tier 1 procedure does not apply for highly reactive pollutants or for releases which are heavier than air (dense gas releases). The Tier 1 procedure is not applicable to scenarios involving non-point sources (i.e., area, volume, or line sources). The procedure is also not applicable to scenarios involving significant terrain height variations or complex building downwash, specifically:

1.   terrain elevation above stack-base elevation exceeds H_s within 50 H_s of the stack location, where H_s = stack height,

2.   any building within 5L of the stack location exceeds the stack height.

If either of these conditions exist, or if non-point sources are involved, a Tier 2 analysis will be necessary.

The Tier 1 procedure involves the following steps:

1.   Determine the stack height (meters) for the HAP source.

2.   Using Equation 5, determine if the stack height is GEP with respect to all nearby structures.

3.   Select the appropriate Table 1 or 2, depending on the GEP status of the stack. Table 1 may be used only if the stack height is GEP with respect to all nearby structures.

4.   In the table, select the row for the stack height nearest to, but less than or equal to, the actual stack height.

5.   Determine the lateral distance (meters) from the HAP release point to the nearest point off-property. (If the property is not bounded by a fence, this distance is zero.)

6.   In the table, select the column for the distance nearest to, but less than, the distance determined in Step 5.

7.   Beginning with the value indicated by the intersection of the row from Step 4 and column from Step 6, proceed down the row

to the right to find the largest value to the right of and including the intersection value.

8. Multiply the value from Step 7 by the 1-hour emission rate for each HAP from the stack, to estimate the maximum off-property 1-hour concentration for each HAP for this stack.

9. If more than one stack is present, repeat Steps 1-8 for each stack. Then, if any stacks have common HAP's, add the Step 8 results for each stack to determine the total off-property 1-hour concentration for each HAP.

10. Determine the maximum individual carcinogenic risk (MICR) for any Group 1 or 2 HAP's. First, multiply the Step 9 results for each Group 1 or 2 HAP by the appropriate conversion factor (Table 3) to estimate a 70-year average concentration. Then, multiply the 70-year average concentration by the Unit Risk Factor for each HAP to determine the MICR for each HAP. Lastly, sum the MICR for individual HAP's (both Group 1 and Group 2) to determine total MICR.

11. Determine the hazard index for Group 3 HAP's. For any HAP's which have 8-hour average MAALs, multiply the total 1-hour concentration (Step 9) by the appropriate conversion factor (Table 3) to estimate a maximum 8-hour concentration. Then, determine the hazard index using Equation 4. Note that for HAP's which have both 1-hour and 8-hour MAALs, the higher of the two ratios (MC/MAAL) should be utilized in Equation 4.

If the total MICR as computed in Step 10 is greater than 1×10^{-6}, a Tier 2 analysis will be necessary for the Group 1 and 2 HAP's. Likewise, if the hazard index computed in Step 11 is greater than one, a Tier 2 analysis will be necessary for the Group 3 HAP's.

Tables 1 and 2 were created using the EPA SCREEN3 model (U.S. EPA, 1995). For a given release height and downwind distance, the SCREEN3 model can select the highest predicted concentration from a matrix of predictions for all plausible meteorological conditions. Plume rise was not considered in developing Tables 1 and 2, thus ensuring conservativeness of the resultant entries. Table 2 was created by entering generic building dimensions into SCREEN3 to simulate structural downwash effects. A range of building sizes for each stack height was considered, including dimensions which induced plume entrainment into the building cavity region (i.e., cavity concentrations). Though the range of simulated building dimensions was limited, the entries in Table 2 are likely conservative for any building configuration, given that plume rise was not accounted for.

Tier 2 Procedure

The Tier 2 procedure involves use of the EPA SCREEN3 computer
screening model (U.S. EPA 1995). For a given set of source
conditions and downwind distances, the SCREEN3 model selects the
highest predicted 1-hour concentration from a matrix of predictions
for all plausible meteorological conditions. The SCREEN3 model can
simulate point and area sources, and building downwash conditions.
Use of SCREEN3 constitutes a less conservative procedure than the
Tier 1 analysis because plume rise and building downwash are more
realistically treated.

The Tier 2 procedure is not applicable for highly reactive
pollutants or for dense gas releases. The Tier 2 procedure may be
applied for area sources (as defined in the SCREEN3 Model User's
Guide), but is not recommended for volume or line sources.

The Tier 2 procedure involves the following steps:

1.   Assemble the source input information necessary for SCREEN3,
     including:
     !   stack height (point source)
     !   stack diameter (point source)
     !   stack gas exit velocity (point source)
     !   stack gas exit temperature (point source)
     !   source length (area source, must be square)
     !   emission release height (area source)

2.   Using Equation 5, determine if the stack height is GEP with
     respect to all nearby structures. If not, building dimensions
     (height, length, width) reflective of the most significant
     nearby structure will be needed (see Tier 1 procedure for a
     description of "nearby").

3.   Execute SCREEN3 using:
     !   unit emission rate (1.0 g/sec)
     !   source parameters from Step 1
     !   all meteorological conditions
     !   ambient temperature of 293ĖK
     !   rural dispersion
     !   receptor elevation of 0.0
     !   a range of receptors which reflects the distance from the
          stack (source) to the closest property boundary (zero if
          no fence), out to at least 100 H_s from the stack (H_s =
          stack/release height)
     !   downwash building dimensions determined in Step 2, if
          downwash is applicable
     !   no terrain screening

4. Execute SCREEN3 again using the input conditions in Step 3, but with the simple terrain screening option, and the five receptors described below:

    !   Receptor 1 - highest terrain feature between the stack location and 25 H_s from the stack location (any radial direction)

    !   Receptor 2 - highest terrain feature between 25 H_s and 50 H_s from the stack location

    !   Receptor 3 - highest terrain feature between 50 H_s and 75 H_s from the stack location

    !   Receptor 4 - highest terrain feature between 75 H_s and 100 H_s from the stack location

    !   Receptor 5 - use the downwind distance associated with the maximum prediction from Step 3, and the maximum elevation for this distance (i.e., in any radial direction)

    H_s = stack height or release height (point or area source, respectively). If the receptor elevation is above stack-top elevation, substitute H_s - 0.1 meter for receptor height. <u>Do Not</u> use complex terrain screening.

    Terrain elevations should be obtained from USGS 7.5 minute topographic maps or digital elevation models. On a case-by-case basis, the Department may determine that terrain screening is not necessary. In this event, the results from Step 3 should be assumed final.

5. Multiply the maximum prediction from Step 4 by the maximum 1-hour emission rate in grams/second for each HAP from the stack, to estimate the maximum off-property 1-hour concentration for each HAP for this stack.

6. If more than one stack is present, repeat Steps 1-5 for each stack. Then, if any stacks have common HAP's, add the Step 5 results for each stack to determine the total off-property 1-hour concentration for each HAP.

7. Determine the MICR for any Group 1 and 2 HAP's. First, multiply the Step 6 results for each Group 1 or 2 HAP by the appropriate conversion factor (Table 3) to estimate a 70-year average concentration. Then, multiply the 70-year average concentration by the Unit Risk Factor (from Appendix D) for each HAP to determine the MICR for each HAP. Lastly, sum the MICR for individual HAP's (both Group 1 and Group 2) to determine total MICR.

8. Determine the hazard index for Group 3 HAP's. For any HAP's
    which have 8-hour average MAALs, multiply the total 1-hour
    concentration (Step 6) by the appropriate conversion factor
    (Table 3) to estimate a maximum 8-hour average concentration.
    Then, determine the hazard index using Equation 4. Note that
    for HAP's which have both 1-hour and 8-hour MAALs, the higher
    of the two ratios (MC/MAAL) should be utilized in Equation 4.

If the total MICR as computed in Step 7 is greater than 1×10^{-6},
a Tier 3 analysis will be necessary for the Group 1 and 2 HAP's.
Likewise, if the hazard index computed in Step 8 is greater than
one, a Tier 3 analysis will be necessary for the Group 3 HAP's.

Tier 3 Procedure

The Tier 3 procedure involves use of refined EPA computer models.
The use of refined models constitutes a less conservative procedure
than Tier 2 primarily because refined models use actual hour-by-
hour meteorological data, and because refined models treat multiple
stack scenarios and elevated terrain more realistically than
SCREEN3.

Candidate models for the Tier 3 procedure include AERMOD (modeling
problem dominated by terrain effects) or ISC-PRIME (modeling
problem dominated by building downwash effects). Other approaches
may be needed if highly reactive pollutants or dense gas releases
are involved.

The procedure for application of refined models is well-documented
elsewhere and, because of its complexity, is not included here.
The reader is referred to the EPA "Guideline on Air Quality Models"
(U.S. EPA 1999) for instructions on refined modeling analyses. The
Department may also be contacted regarding procedures for refined
analyses.

VARIANCES AND SPECIAL CONSIDERATION

A variance from compliance with a requirement of this policy may be
granted by the Department for the emission of any substance in
accordance with 33-15-01-07 of the Rules, if the affected facility
can demonstrate to the satisfaction of the Department that
compliance with the requirement from which the facility is
requesting a variance is economically infeasible compared to the
societal benefits of the source. In no case shall exemption from
a requirement of this policy result in a projected aggregate cancer
incidence in the exposed population in excess of 1 individual.
Also, in no case shall a source which is emitting a substance that
is also regulated under NSPS, NESHAP or MACT be allowed to obtain
a variance to a requirement of this policy which is less stringent
than the requirements of NSPS, NESHAP, or MACT.

When classifying substances as Group 1, Group 2, or Group 3, the Department will use the most restrictive classification where lists from the ACGIH, IARC, NTP or EPA do not agree. For example, benzene is classified as a known human carcinogen by NTP and EPA and a Group 1 substance by the Department, although classified as a suspected human carcinogen by ACGIH. As new information becomes available through the NTP, ACGIH, IARC or EPA, the composition of Group 1, Group 2, or Group 3 may change. These lists will be periodically reviewed by the Department. The Department will also consider alternative classifications for a specific Group 1, Group 2, or Group 3 substance and an alternative MAAL for a Group 3 substance, provided the affected source or person(s) can demonstrate to the satisfaction of the Department by presenting scientific data that reclassification or an alternative MAAL is more scientifically valid.

Risk assessments should be conducted according to the procedure outlined in the section of this document entitled "Dispersion Modeling Procedure." The unit risk factors given in Appendix D are from the Federal Register, February 21, 1991 and EPA's IRIS database. Should new unit risk factors be published by EPA, the latest version must be used in any analysis. The Department acknowledges the problem of exposure from multiple environmental pathways, but will presently consider only exposure through the air. Any questions concerning the appropriate models for the risk assessments should be directed to the Department prior to performing these assessments.

LIMITATIONS OF THE APPROACH

There are several limitations to the TLV approach for noncarcinogens. The ACGIH handbook clearly states that the TLV's "... are guidelines or recommendations for the control of potential health hazards and for no other use, e.g., ... in estimating the toxic potential of continuous, uninterrupted exposures...". This is in part because the TLV-TWA permits excursions above the specified concentration provided equivalent excursions below the limit occur. The TLV approach also ignores possible antagonistic responses between HAP's, frequently provides one TLV for substances with many valences or isomers, assumes an arbitrary safety factor, adjusts the TLV to an appropriate exposure for hypersensitive portions of the exposed population, and assumes a dose incurred during a 40-hour workweek has the same effects as if the dose was incurred continuously for one week. Despite these limitations, the TLV approach is the best methodology available considering the limited resources. Also, the MAAL's set by this method are being used as a "trigger" for further review of sources where a potential problem may be likely, not as an ambient standard.

Limitations of the risk assessment are directly related to an inability to assign uncertainty to numbers used in the risk assessment process. Because of the assumption of "no threshold dose" for carcinogens and a linear extrapolation of the data to considerably lower risks, the unit risk factor is an upper estimate of the potency. The actual potency may be considerably less.

Any questions about this document should be directed to:

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      Bismarck, ND 58506-5520
      Phone: 701-328-5188

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TABLE 1

MAXIMUM NORMALIZED 1-HOUR CONCENTRATIONS[1] - GEP STACKS (mg/m^3)

Stack Ht. (meters)	Downwind Distance (meters)													
	10	20	30	40	50	75	100	150	200	300	400	500	750	1000
1	149	156	142	110	85	48	31	16	9.8	5.0	3.1	2.1	1.1	.67
5	.41	4.3	5.0	5.5	5.5	5.4	5.4	5.0	4.8	3.4	2.4	1.8	.97	.63
10	[2]neg.	.007	.64	1.1	1.2	1.3	1.4	1.3	1.2	1.1	1.1	1.0	.72	.52
20	neg.	neg.	neg.	.013	.064	.23	.29	.31	.32	.27	.27	.24	.19	.16
30	neg.	neg.	neg.	neg.	neg.	.025	.078	.13	.13	.14	.13	.11	.10	.080
50	neg.	neg.	neg.	neg.	neg.	neg.	.0012	.022	.045	.048	.084	.046	.041	.034
100	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	.0086	.015	.015	.013	.011
200	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	.0035	.0060	.0048

[1]Normalized with respect to emission rate (1.0 grams/sec used)

[2]neg. = negligible, defined as less than 0.001 milligrams/m^3

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TABLE 2

MAXIMUM NORMALIZED 1-HOUR CONCENTRATIONS[1] - NON-GEP STACKS (mg/m^3)

Stack Ht. (meters)	Downwind Distance (meters)													
	10	20	30	40	50	75	100	150	200	300	400	500	750	1000
1	149	156	142	110	85	48	31	16	9.8	5.0	3.1	2.1	1.1	.67
5	23	17	19	18	16	12	9.3	6.5	4.9	3.4	2.4	1.8	.97	.63
10	5.8	3.8	3.8	4.5	4.9	5.0	4.0	3.0	2.4	1.7	1.3	1.1	.72	.52
20	1.5	1.5	.60	.60	.60	.78	.88	.89	.71	.52	.42	.35	.25	.19
30	.65	.65	.65	.22	.22	.22	.27	.32	.33	.26	.21	.17	.12	.099
50	[2]neg.	neg.	neg.	neg.	neg.	neg.	neg.	.071	.084	.094	.087	.073	.055	.044
100	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	.024	.025	.025	.024	.019
200	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	.0035	.0060	.0049

[1]Normalized with respect to emission rate (1.0 grams/sec used)

[2]neg. = negligible, defined as less than 0.001 milligrams/m^3

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TABLE 3
CONVERSION OF 1-HOUR CONCENTRATIONS
TO OTHER AVERAGING TIMES

Averaging Time	Multiplying Factor
8 hours	0.7
70 years	0.08

Appendix A. Group 1 hazardous air pollutants known to cause cancer in humans.

4-Aminodiphenyl
Arsenic (elemental and inorganic compounds)
Asbestos
Auramine
Benzene
Benzidine
Bis(chloromethyl)ether (BCME) and technical grade chloromethyl methyl ether (CMME)
Chromium VI compounds
Coal tar pitch volatiles
Coke oven emissions
2-Naphthylamine
Nickel, insoluble nickel compounds (including nickel carbonyl)
4-Nitrodiphenyl
Tetranitromethane
Thorium dioxide
Vinyl chloride
Zinc Chromates

Manufacture of Pharmaceuticals:
     Azathioprine, N,N-bis(2-chloroethyl)-2-naphthylamine (chlornaphazine), 1,4-Butanediol dimethylsulfonate   (myleran), Chlorambucil, Conjugated estrogens, Cyclophosphamide, Diethylstilbestrol (DES), Melphalan, Mustard Gas, N,N-Bis (2-chloroethyl)-2naphthylamine, Phenacetin, Treosulphan, certain chemotherapeutics

Appendix B. Group 2 hazardous air pollutants suspected of causing cancer in humans.

Acetaldehyde
2-Acetylaminofluorene
Acrylamide
Acrylonitrile
Aflatoxins
Aldrin
2-Aminoanthraquinone
1-Amino-2-methylanthraquinone
Aniline
o-Anisidine and o-anisidine hydrochloride
Antimony trioxide
Benzo (b) fluoranthene
Benzo (a) pyrene
Benzotrichloride
Benzyl chloride
Beryllium and beryllium compounds
Bis(2-ethylhexyl)phthalate (DEHP)
Bromoform
1,3-Butadiene
Cadmium and cadmium compounds
Calcium chromate
Carbon tetrachloride
Chlordane
Chlorinated camphene (toxaphene)
Chloroform
4-Chloro-o-phenylenediamine
Chrysene
p-Cresidine
Cupferron
Cycasin
DDE(p,p'-Dichlorodiphenyldichloroethylene)
DDT(Dichlorodiphenyl-trichloroethane)
2,4-Diaminoanisole sulfate
2,4-Diaminotoluene
Diazomethane
Di(2-ethylhexyl)phthalate
1,2-Dibromo-3-chloropropane (DBCP) (pesticide)
1,2-Dibromoethane (EDB)
3,3'-Dichlorobenzidine
1,2-Dichloroethane (EDC)
Dichloroethyl ether
1,3-Dichloropropene
Diepoxybutane
Diethyl sulfate
1,1-Dimethylhydrazine
Dimethyl sulfate
3,3-Dimethyoxybenzidine (o-dianisidine)
4-Dimethylaminoazobenzene

3,3'-Dimethylbenzidine
Dimethylcarbamoyl chloride
Dinitrotoulene
2,4-Dinitrotoluene
1,4-Dioxane
1,2-Diphenylhydrazine
Direct black 38
Direct blue 6
Epichlorohydrin(1-chloro-2,3-epoxypropane)
Ethyl acrylate
Ethyl bromide
Ethylene dibromide (Dibromomethane)
Ethylene dichloride (1,2-Dichloroethane)
Ethylene oxide
Ethylene thiourea
Formaldehyde
Heptachlor
Hexachlorobenzene (HCB)
Hexachlorobutadiene
Hexachloroethane
Hexamethylphosphoramide
Hydrazine and hydrazine sulfate
Hydrazobenzene
Lindane and other hexachlorocyclohexane isomers
4,4'-Methylene bis(2-chloroaniline) (MOCA)
4,4'-Methylenebis(N,N-dimethyl)benzenamine
Methylene chloride
4,4'-Methylene dianiline and its dihydrochloride
Methyl hydrazine
Methyl iodide
Milcher's ketone
5-Nitro-o-anisidine
Nitrilotriacetic acid
2-Nitropropane
N-Nitrosodi-n-butlyamine
N-Nitrosodiethanolamine
N-Nitrosodiethylamine
N-Nitrosodimethylamine
p-Nitrosodiphenylamine
N-Nitrosodi-n-propylamine
N-Nitroso-N-ethylurea
N-Nitroso-N-methylurea
N-Nitrosomethylvinylamine
N-Nitrosomorpholine
N-Nitrosonornicotine
N-Nitrosopiperidine
N-Nitrosopyrrolidine
N-Nitrososarcosine
Pentachlorophenol
N-phenyl-beta-naphthylamine
O-Phenylenediamine

Phenylhydrazine
Polybrominated biphenyls (PBB)
Polychlorinated biphenyls (PCB)
Propane sultone
beta-Propiolactone
2-Methylaziridine (Propyleneimine)
Propylene oxide
Silica-crystalline quartz
Strontium chromate
Sulfuric acid, strong inorganic acid mists
2,3,7,8-Tetrachloro-dibenzo-p-dioxin
Tetrachloroethylene (Perchloroethylene)
Thioacetamide
Thiourea
o-Tolidine
Toluene diisocyanate
o-Toluidine and o-toluidine hydrochloride
p-Toluidine
Toxaphene (chlorinated camphene)
2,4,6-Trichlorophenol
Tris(2,3-dibromopropyl)phosphate
Urethane
Vinyl bromide
4-Vinyl cyclohexene
Vinyl cyclohexene dioxide
Xylidine (mixed isomers)

Polycyclic Organic Matter:
    benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene,
dibenz(a,h)acridine, dibenz(a,j)acridine, dibenz(a,h)anthracene,
7H-dibenzo(c,g)carbazole, dibenzo(a,h)pyrene, dibenzo(a,i)pyrene,
ideno(1,2,3-cd)pyrene

Manufacture of Agricultural Herbicides, Pesticides, and Fungacides:
    Amitrole, Aramite (registration cancelled 1979), DDT, Kepone
(Chlordecone), Mirex, Nitrofen (2,4-dichlorophenyl-p-
nitrophenylether), Sulfallate (diethyl-dithiocarbamic acid 2-
chloroallyl ester), Toxaphene, 2,4,6-Trichlorophenol

Manufacture of Pharmaceuticals:
    Adriamycin, 1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea
(CCNU), Dacarbazine, Ethinylestradiol, Iron dextran complex,
Mestranol, Metronidazole, Norethisterone, Estrogens and
progestins (not conjugated), Estrone, Phenazopyridine
hydrochloride, Phenytoin and sodium salt of phenytoin,
Propylthiouracil, Reserpine, Selenium sulfide, Streptozotocin,
Tris(1-aziridinyl)phosphine sulfide, uracil, Nitrogen mustard

Appendix C. Group 3 hazardous air pollutants which are noncarcinogenic or have insufficient data for classification with respect to carcinogenicity and their MAAL(s).

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Acetic acid	0.24523	0.36784
Acetic anhydride	0.20863	
Acetone	11.86292	17.79438
Acetone cyanohydrin, as CN		0.05000
Acetonitrile	0.03311	
Acetophenone	0.49107	
Acetylene tetrabromide	0.14129	
Acetylsalicylic acid (aspirin)	0.05000	
Acrolein		0.00229
Acrylic acid	0.05890	
Adipic acid	0.05000	
Adiponitrile	0.08836	
Allyl alcohol	0.01187	
Allyl chloride	0.03127	0.06253
Allyl glycidyl ether (AGE)	0.04665	
Allyl propyl disulfide	0.12111	0.18167

Aluminum and compounds as Al
    Metal dust
    Pyro powders, as Al
    Welding fumes, as Al
    Soluble salts, as Al
    Alkyls, as Al
	
	0.10000
	0.05000
	0.05000
	0.02000
	0.02000	

2-Aminopyridine	0.01862	
Amitrole	0.00200	
Ammonia	0.17401	0.24361
Ammonium chloride fumes	0.10000	0.20000
Ammonium perfluorooctanoate	0.00010	
Ammonium sulfamate	0.10000	
tert-Amyl methyl ether (TAME)	0.83541	
Anisidine (p- isomer)	0.00500	
Antimony & compounds, as Sb	0.00500	
Antimony hydride	0.00510	
ANTU	0.00300	
Arsine	0.00159	
Asphalt (petroleum) fumes	0.00500	
Atrazine	0.05000	
Azinphos-methyl	0.00200	
Barium, soluble compounds, as Ba	0.00500	
Barium sulfate	0.10000	
Benomyl	0.10000	
Benzoyl chloride		0.02873
Benzoyl peroxide	0.05000	

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Benzyl acetate	0.61381	
Biphenyl	0.01260	
Bis(2-dimethylaminoehtyl) ether (DMAEE)	0.00328	0.00983
Bismuth telluride		
Undoped	0.10000	
Se-doped(as Bi2Te3)	0.05000	
Borates, tetra, sodium salts		
Anhydrous	0.01000	
Decahydrate	0.05000	
Pentahydrate	0.01000	
Boron oxide	0.10000	
Boron tribromide (c)		0.10241
Boron trifluoride (c)		0.02772
Bromacil	0.10000	
Bromine	0.00653	0.01306
Bromine pentafluoride	0.00715	
Butane	19.00356	
n-Butanol (c)	0.60588	
sec-Butanol	3.02939	
tert-Butanol	3.02939	
2-Butoxyethanol (EGBE)	0.96595	
2-Butoxyethyl acetate (EGBEA)	1.30952	
Butyl acetate		
n-	7.12143	9.49524
sec-	9.49524	
tert-	9.49524	
N-Butyl acrylate	1.04770	
N-Butylamine (c)	.	0.14947
Butylated hydroxytoluene (BHT)	0.02000	
tert-Butyl chromate, as Cr03 (c)		0.00100
n-Butyl glycidyl ether (BGE)	1.33047	
n-Butyl lactate	0.29875	
n-Butyl mercaptan	0.01843	
o-sec-Butylphenol	0.30698	
p-tert-Butyltoluene	0.06056	
Calcium carbonate	0.10000	
Calcium cyanamide	0.00500	
Calcium hydroxide	0.05000	
Calcium oxide	0.02000	
Calcium silicate (synthetic)	0.10000	
Calcium sulfate	0.10000	
Camphor, synthetic	0.12452	0.18678
Caprolactam	0.05000	
Captafol	0.00100	
Captan	0.05000	
Carbaryl	0.05000	

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Carbofuran	0.00100	
Carbon black	0.03500	
Carbon disulfide	0.31119	
Carbon tetrabromide	0.01355	0.04066
Carbonyl fluoride	0.05396	
Catechol	0.22502	
Cellulose	0.10000	
Cesium hydroxide	0.02000	
o-Chlorinated diphenyl oxide	0.00500	
Chlorine	0.01449	0.00290
Chlorine dioxide	0.00276	0.00827
Chlorine trifluoride (c)		0.00378
Chloroacetaldehyde (c)		0.03208
Chloroacetone		0.03782
2-Chloroacetophenone	0.00316	
Chloroacetyl chloride	0.00231	0.00692
Chlorobenzene	0.46005	
o-Chlorobenzylidene malononitrile (c)		0.00385
Chlorobromomethane	10.57670	
Chlorodifluoromethane	35.34148	
Chlorodiphenyl (42% chlorine)	0.01000	
Chlorodiphenyl (54% chlorine)	0.00500	
1-Chloro-1-nitropropane	0.10099	
Chloropentafluoroethane	63.13402	
Chloropicrin	0.00672	
1-Chloro-2-propanol and 2-Chloro-1-propanol	0.03864	
beta-Chloroprene	0.36188	
2-Chloropropionic acid	0.00444	
o-Chlorostyrene	2.83239	4.24858
o-Chlorotoluene	2.58695	
Chlorpyrifos	0.00100	
Chromium, metal, and inorganic compounds, as Cr Metal and Cr III compounds	0.00500	
Chromyl choride	0.00158	
Clopidol	0.10000	
Cobalt, elemental, and inorganic compounds, as Co	0.00020	
Cobalt carbonyl, as Co	0.00100	
Cobalt hydrocarbonyl, as Co	0.00100	

Copper
    Fume
      Dusts & mists, as Cu
	0.00200
	0.01000	

Cotton dust, raw	0.00200	
Cresol, all isomers	0.22099	
Crotonaldehyde		0.00859
Crufomate	0.05000	
Cumene	2.45617	

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Cyanamide	0.02000	
Cyanogen	0.21269	
Cyanogen chloride (C)		0.00754
Cyclohexane	3.43974	
Cyclohexanol	2.04684	
Cyclohexanone	0.80222	2.00556
Cyclohexene	10.07152	
Cyclohexylamine	0.40532	
Cyclonite	0.00500	
Cyclopentadiene	2.02620	
Cyclopentane	17.19786	
Cyhexatin	0.05000	
2,4-D	0.10000	
Decaborane	0.00250	0.00750
Demeton	0.00050	
Demeton-S-methyl	0.00050	
Diacetone alcohol	2.37381	
Diazinon	0.00010	
Diborane	0.00113	
2-N-Dibutylaminoethanol	0.03541	
Dibutyl phenyl phosphate	0.03510	
Dibutyl phosphate	0.08592	0.17183
Dibutyl phthalate	0.05000	
Dichloroacetylene (c)		0.00388
o-Dichlorobenzene	1.50304	3.00609
p-Dichlorobenzene	0.60122	
Dichlorodifluoromethane	49.41758	
1,3-Dichloro-5,5-dimethyl hydantoin	0.00200	0.00400
1,1-Dichloroethane	4.04504	
1,2-Dichloroethylene	7.92496	
Dichlorofluoromethane	0.42065	
Dichloromethane	1.73560	
1,1-Dichloro-1-nitroethane	0.11768	
2,2-Dichloropropionic acid	0.05000	
Dichlorotetrafluoroethane	69.86145	
Dichlorvos (DDVP)	0.00100	
Dicrotophos	0.00050	
Dicyclopentadiene	0.27018	
Dicyclopentadienyl iron	0.10000	
Dieldrin	0.00250	
Diesel fuel	1.00000	
Diethanolamine	0.02000	
Diethylamine	0.14947	0.44840
2-Diethylaminoethanol	0.09579	
Diethylene triamine	0.04217	

Contaminant	MAAL 8-hour (mg/m³)	MAAL 1-hour (mg/m³)
Diethyl ketone	7.04050	10.56076
Diethyl phthalate	0.05000	
Difluorodibromomethane	8.57604	
Diglycidyl ether (DGE)	0.00532	
Diisobutyl ketone	1.45328	
Diisopropylamine	0.20679	
N,N-Dimethylacetamide	0.35607	
Dimethylamine	0.09212	0.27637
Dimethylaniline (N,N-Dimethylaniline)	0.24764	0.49528
Dimethylethoxysilane	0.02129	0.06388
Dimethylformamide	0.29873	
Dimethylphthalate	0.05000	
Dinitolmide	0.05000	
Dinitrobenzene (all isomers)	0.01031	
Dinitro-o-cresol	0.00200	
Dioxathion	0.00100	
1,3-Dioxolane	0.72015	
Diphenylamine	0.10000	
Dipropyl ketone	2.34602	

Diquat
    Total Dust
    Respirable Fraction
	
	0.00500
	0.00100	

Disulfiram	0.02000	
Disulfoton	0.00050	
Diuron	0.10000	
Divinyl benzene	0.53210	
Emery	0.10000	
Endosulfan	0.00100	
Endrin	0.00100	
Enflurane	5.65558	
EPN	0.00100	
Ethanol	18.82944	
Ethanolamine	0.07489	0.14979
Ethion	0.00050	
2-Ethoxyethanol (EGEE)	0.18417	
2-Ethoxyethyl acetate (EGEEA)	0.27008	
Ethyl acetate	14.40307	
Ethyl acrylate	0.20458	0.61375
Ethylamine	0.09212	0.27637
Ethyl amyl ketone	1.31003	
Ethyl benzene	4.33891	5.42363
Ethyl tert butyl ehter (ETBE)	0.20881	
Ethyl butyl ketone	2.33355	3.50033
Ethyl chloride	2.63702	
Ethyl cyanoacrylate	0.01023	
Ethylene chlorohydrin (c)	0.03291	

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Ethylenediamine	0.24564	
Ethylene glycol, aerosol		1.00000
Ethylene glycol dinitrate	0.00311	
Ethylenimine	0.00880	
Ethyl ether	12.11755	15.14693
Ethyl formate	3.02775	
2-Ethylhexanoic acid	0.05000	
Ethylidene norbornene (c)		0.24562
Ethyl mercaptan	0.01270	
N-Ethylmorpholine	0.23538	
Ethyl silicate	0.85135	
Fenamiphos	0.00100	
Fensulfothion	0.00100	
Fenthion	0.00200	
Ferbam	0.10000	
Ferrovanadium dust	0.01000	0.03000
Flour dust	0.00500	
Fluorides, as F	0.02500	
Fluorine	0.01553	0.03106
Fonofos	0.00100	
Formamide	0.18408	
Formic Acid	0.09405	0.18809
Furfural	0.07854	
Furfuryl alcohol	0.40095	0.60142
Gasoline	8.58299	14.30498
Germanium tetrahydride	0.00626	
Glutaraldehyde (c)		0.00205
Glycerin mist	0.10000	
Glycidol	0.06056	
Glyoxal	0.00100	
Graphite, all forms except graphite fibers	0.02000	
Hafnium	0.00500	
Halothane	4.03380	
Heptane (n-Heptane)	16.38125	20.47656
Hexachlorocyclopentadiene	0.00111	
Hexachloronaphthalene	0.00200	
Hexafluoroacetone	0.00679	
Hexamethylene diisocyanate	0.00034	
n-Hexane	1.76115	
other isomers	17.61148	35.22295
1,6-Hexanediamine	0.02375	
1-Hexene	1.71987	
sec-Hexyl acetate	2.94703	
Hexylene glycol (c)		1.20744
Hydrogenated terphenyls	0.04925	

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Hydrogen bromide (c)		0.09922
Hydrogen chloride (c)		0.02981
Hydrogen cyanide (c)		0.05192
Cyanide salts		0.05000
Hydrogen fluoride (c)		0.02454
Hydrogen peroxide	0.01390	
Hydrogen selenide	0.00165	
Hydroquinone	0.02000	
2-Hydroxypropyl acrylate	0.02660	
Indene	0.47472	
Indium and compounds, as In	0.00100	
Iodine (c)		0.01037
Iodoform	0.09657	
Iron oxide dust and fume (Fe2O3), as Fe	0.05000	
Iron pentacarbonyl, as Fe	0.00801	0.01601
Iron salts, soluble as Fe	0.01000	
Isoamyl alcohol	3.60281	4.50351
Isobutyl acetate	7.12143	
Isobutyl alcohol	1.51469	
Isobutyl nitrite		0.04215
Isooctyl alcohol	2.66134	
Isophorone (c)		0.28244
Isophorone diisocyanate	0.00045	
2-Isopropoxyethanol	1.06419	
Isopropyl acetate	4.17419	8.34839
Isopropanol	4.91192	9.82384
Isopropylamine	0.12073	0.24147
N-isopropylaniline	0.11052	
Isopropyl ether	10.43957	12.94507
Isopropyl glycidyl ether (IGE)	2.37422	3.56133
Kaolin	0.02000	
Kerosene / Jet fuels	2.00000	
Ketene	0.00859	0.02577
Lead arsenate, as Pb3(AsO4)2	0.00150	
Lindane	0.00500	
Lithium hydride	0.00025	
L.P.G. (liquified petroleum gas)	20.43569	
Magnesite	0.10000	
Magnesium oxide	0.10000	
Malathion	0.01000	
Maleic anhydride	0.00401	
Manganese, elemental and inorganic compounds, as MN	0.00200	
Manganese cyclopentadienyl tricarbonyl, as MN	0.00100	

Mercury, as Hg
    Alkyl compounds
    Aryl compounds
	
	0.00010
	0.00100
		
		0.00030

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Inorganic and elemental mercury	0.00025	
Mesityl oxide	0.60167	1.00278
Methacrylic acid	0.70372	
Methanol	2.61904	3.27380
Methomyl	0.02500	
Methoxyclor	0.10000	
2-Methoxyethanol (EGME)	0.15550	
2-Methoxyethyl acetate (EGMEA)	0.24141	
4-Methoxyphenol	0.05000	
1-Methoxy-2-propanol (PGME)	3.68333	5.52499
bis-(2-Methoxypropyl) ether (DPGME)	6.05714	9.08571
Methyl acetate	6.37920	7.97401
Methyl acetylene	16.37716	
Methyl acetylene-propadiene mixture (MAPP)	16.37716	20.47145
Methyl acrylate	0.07037	
Methylacrylonitrile	0.02742	
Methylal	31.10312	
Methylamine	0.06347	0.19042
Methyl n-amyl ketone	2.33335	
N-Methyl aniline	0.02190	
Methyl bromide	0.03881	
Methyl-tert butyl ether	1.80181	
Methyl n-butyl ketone	0.20468	0.40937
Methyl chloride	1.03180	2.06360
Methyl chloroform	19.08571	24.53877
Methyl 2-cyanoacrylate	0.00908	
Methylcyclohexane	16.05264	
Methylcyclohexanol	2.33355	
o-Methylcyclohexanone	2.29227	3.43841
2- Methylcyclopentadienyl manganese tricarbonyl, as Mn	0.00200	
Methyl demeton	0.00500	
Methylene bisphenyl isocyanate (MDI)	0.00051	
Methylene bis (4-cyclo-hexylisocyanate)	0.00054	
Methyl ethyl ketone (MEK)	5.89365	8.84048
Methyl ethyl ketone peroxide (c)		0.01441
Methyl formate	2.65868	3.98802
Methyl iodide	0.11603	
Methyl isoamyl ketone	2.33376	
Methyl isobutyl carbinol	1.04406	1.67049
Methyl isobutyl ketone	2.04684	3.07026
Methyl isocyanate	0.00047	
Methyl isopropyl ketone	7.04132	
Methyl mercaptan	0.00983	
Methyl methacrylate	2.04623	4.09245
Methyl parathion	0.00200	

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Methyl propyl ketone	7.04377	8.80472
Methyl silicate	0.06221	
alpha-Methyl styrene	2.41509	4.83018
Methyl vinyl ketone		0.00573
Metribuzin	0.05000	
Mevinphos	0.00010	
Mica	0.03000	

Molybdenum, as Mo
    Soluble compounds
    Metal and Insoluble compounds (respirable fraction)
    Metal and Insoluble compounds (total)
	
	0.00500
	0.03000
	0.10000	

Monocrotophos	0.00050	
Morpholine	0.71214	
Naled	0.00100	
Naphthalene	0.52393	0.78590

Nickel
    Elemental
    Soluble inorganic compounds, as Ni
	
	0.01500
	0.00100	

Nickel carbonyl, as Ni	0.00349	
Nicotine	0.00500	
Nitrapyrin	0.10000	0.20000
Nitric acid	0.05151	0.10303
Nitric oxide	0.30664	
p-Nitroanaline	0.03000	
Nitrobenzene	0.05032	
p-Nitrochlorobenzene	0.00644	
Nitroethane	3.06821	
Nitrogen trifluoride	0.29019	
Nitroglycerin	0.00464	
Nitromethane	0.49896	
1-Nitropropane	0.91031	
Nitrotoluene	0.11209	
Nitrous oxide	0.89958	
Nonane	10.48433	
Octachloronaphthalene	0.00100	0.00300
Octane	14.00499	
Oil mist, mineral	0.05000	0.10000
Osmium tetroxide, as Os	0.00002	0.00006
Oxalic acid	0.01000	0.02000
p,p-Oxybis(benzenesulfonyl hydrazine)	0.00100	
Oxygen difluoride (c)		0.00110
Paraffin wax fume	0.02000	

Paraquat,
    total dust
    respirable fraction
	
	0.00500
	0.00100	

Parathion	0.00050	

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Pentaborane	0.00013	0.00039
Pentachloronaphthalene	0.00500	
Pentachloronitrobenzene	0.00500	
Pentaerythritol	0.10000	
Pentane, all isomers	17.69322	
Pentyl acetate, all isomers	2.66073	5.32145
Perchloromethyl mercaptan	0.00760	
Perchloryl fluoride	0.12563	0.25126
Perfluoroisobutylene		0.00082
Perlite	0.10000	
Persulfates, as persulfate	0.00100	
Phenol	0.19232	
Phenothiazine	0.05000	
M-Phenylenediamine	0.00100	
p-Phenylenediamine	0.00100	
Phenyl ether vapor	0.06956	0.13913
Phenyl glycidyl ether (PGE)	0.00614	
Phenyl mercaptan	0.02252	
Phenylphosphine (c)		0.00225
Phorate	0.00050	0.00200
Phosgene	0.00404	
Phosphine	0.00417	0.01390
Phosphoric acid	0.01000	0.03000
Phosphorus (yellow)	0.00100	
Phosphorus oxychloride	0.00627	
Phosphorus pentachloride	0.00851	
Phosphorus pentasulfide	0.01000	0.03000
Phosphorus trichloride	0.01123	0.02807
Phthalic anhydride	0.06053	
m-Phthalodinitrile	0.05000	
Picloram	0.10000	
Picric acid	0.00100	
Pindone	0.00100	
Piperazine dihydrochloride	0.05000	

Platinum
    Metal
    Soluble salts, as Pt
	
	0.01000
	0.00002	

Potassium hydroxide (c)		0.02000
Propargyl alcohol	0.02291	
beta-Propiolactone	0.01473	
Propionaldehyde	0.47493	
Propionic acid	0.30278	
Propoxur	0.00500	
n-Propyl acetate	8.34839	10.43548
n-Propyl alcohol	4.91192	6.13990
Propylene dichloride	3.46354	5.07986

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Propyl glycol dinitrate	0.00339	
n-Propyl nitrate	1.07379	1.71807
Pyrethrum	0.05000	
Pyridine	0.16165	
Quinone	0.00442	
Resorcinol	0.45003	0.90007

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Rhodium		
Metal	0.01000	
Insoluble compounds, as Rh	0.01000	
Soluble compounds, as Rh	0.00010	
Ronnel	0.10000	
Rotenone (commercial)	0.05000	
Rouge	0.10000	
Rubber solvent (Naphtha)	15.85809	
Selenium and compounds, as Se	0.00200	
Selenium hexafluoride, as Se	0.00394	
Sesone	0.10000	
Silica-amorphous		
Diatomaceous earth (uncalcined) .	0.10000	
Respirable portion	0.03000	
Precipitated silica	0.10000	
Silica, fume	0.02000	
Silica, fused	0.00100	
Silica-crystalline		
Cristobalite	0.00050	
Tridymite	0.00050	
Tripoli,as quartz	0.00100	
Silicon	0.10000	
Silicon carbide (nonfibrous)		
Total dust	0.10000	
Respirable fraction	0.03000	
Silver		
Metal	0.00100	
Soluble compounds, as Ag	0.00010	
Soapstone		
Total dust	0.06000	
Respirable fraction	0.03000	
Sodium azide © as sodium azide		0.00290
as Hydrazoic acid vapor		0.00110
Sodium bisulfite	0.05000	
Sodium fluoroacetate	0.00050	
Sodium hydroxide (c)		0.02000
Sodium metabisulfite	0.05000	
Starch	0.10000	
Stearates	0.10000	
Stoddard solvent	5.72199	
Strychnine	0.00150	
Styrene, monomer	0.85143	1.70287
Subtilisins, crystalline active enzyme		0.00000
Sucrose	0.10000	
Sulfometuron methyl	0.05000	
Sulfotep	0.00200	
Sulfur hexafluoride	59.70082	
Sulfuric acid	0.01000	0.03000

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Sulfur monochloride (c)		0.05519
Sulfur pentafluoride (c)		0.00104
Sulfur tetrafluoride (c)		0.00442
Sulfuryl fluoride	0.20859	0.41717
Sulprofos	0.01000	
Synthetic vitreous fibers
Continuous filament glass fibers	0.05000	
2,4,5-T	0.10000	
Talc containing no asbestos fibers	0.02000	
Tantalum, metal and oxide dusts, as Ta	0.05000	
Tellurium and compounds, as Te	0.00100	
Tellurium hexafluoride	0.00197	
Temephos	0.10000	
Terbufos	0.00010	
Terephthalic acid	0.10000	
TEPP		
Terphenyls (c)		0.05000
1,1,1,2-Tetrachloro-2,2-difluoroethane	41.65406	
1,1,2,2-Tetrachloro-1,2-difluoroethane	41.65406	
1,1,2,2,-Tetrachloroethane	0.06861	
Tetrachloronaphthlene	0.02000	
Tetraethyl lead, as Pb	0.00100	
Tetraethyl pyrophosphate	0.00050	
Tetrafluoroethylene	0.08191	
Tetrahydrofuran	5.89365	7.36707
Tetramethyl lead, as Pb	0.00150	
Tetramethyl succinonitrile	0.02783	
Tetrasodium pyrophosphate	0.05000	
Tetryl	0.01500	
Thallium, elemental and soluble compounds, as Tl	0.00100	
4,4'-Thiobis(6-tert,butyl-m-cresol)	0.10000	
Thioglycolic acid	0.03765	
Thionyl chloride (c)		0.04863
Thiram	0.01000	
Tin
Metal
Oxide & inorganic compounds, except tin hydride
Organic compounds, as Sn	0.02000
0.02000
0.00100	0.00200
Titanium dioxide	0.10000	
Toluene	1.88274	
Toluene-2,4-diisocyanate (TDI)	0.00036	0.00142
Toluidine	0.08759	
Tributyl phosphate	0.02177	
Trichloroacetic acid	0.06678	
1,2,4-Trichlorobenzene (c)		0.37083
1,1,2-Trichloroethane	0.54527	

Contaminant	MAAL 8-hour (mg/m^3)	MAAL 1-hour (mg/m^3)
Trichloroethylene	2.68525	5.37050
Trichlorofluoromethane (c)		56.14910
Trichloronaphthalene	0.05000	
1,2,3-Trichloropropane	0.60257	
1,1,2-Trichloro-1,2,2 trifluoroethane	76.59296	95.74120
Trichlorphon	0.01000	
Triethanolamine	0.05000	
Triethylamine	0.04136	0.12407
Trifluorobromomethane	60.86566	
1,3,5-Triglycidyl-s-triazinetrione	0.00050	
Trimellitic anhydride		0.00040
Trimethylamine	0.12080	0.36239
Trimethyl benzene	1.22808	
Trimethyl phosphite	0.10143	
2,4,6-Trinitrotoluene (TNT)	0.00100	
Triorthocresyl phosphate	0.00100	
Triphenyl amine	0.05000	
Triphenyl phosphate	0.03000	
Tungsten, as W		
Metal and Insoluble compounds	0.05000	0.10000
Soluble compounds	0.01000	0.03000
Turpentine	1.11170	
Uranium (natural)		
Soluble & Insoluble compounds, as U	0.00200	0.00600
n-Valeraldehyde	1.76013	
Vanadium pentoxide, as V205, dust or fumes	0.00050	
Vegetable oil, mists	0.10000	
Vinyl acetate	0.35186	0.52779
n-Vinyl-2-pyrrolidone	0.00227	
Vinylidene chloride	0.19812	
Vinylidene fluoride	13.08702	
Vinyl toluene	2.41509	4.83018
VM & P Naphtha	13.97801	
Warfarin	0.00100	
Welding fumes (not otherwise classified)	0.05000	
Wood dust (certain hard woods as beech & oak)	0.01000	
Soft Wood	0.05000	0.10000
Xylene	4.33891	6.50836
m-Xylene a,a'-diamine (c)		0.00100
Yttrium, metal and compounds, as Y	0.01000	
Zinc chloride fume	0.01000	0.02000
Zinc oxide	0.02000	0.10000
Zirconium and compounds, as Zr	0.05000	0.10000

Appendix D. Unit risk factors for carcinogenic constituents.

Contaminant	Unit Risk Factor (m³/Fg)
Acetaldehyde	2.2E-06
Acetamide	2.0E-05
Acrylamide	1.3 E-03
Acrylonitrile	6.8 E-05
Aldrin	4.9 E-03
Allyl chloride	6.0E-06
Aniline	1.6 E-06
Arsenic	4.3 E-03
Benzene	7.8 E-06
Benzidine	6.7 E-02
Benzo(a)anthracene	1.1 E-04
Benzo(a)pyrene	1.1 E-03
Benzo(b)fluoranthene	1.1E-04
Benzo(j)fluoranthene	1.1E-04
Benzo(k)fluoranthene	1.1E-04
Benzotrichloride	3.7E-03
Benzyl choride	4.9E-05
Beryllium	2.4 E-03
Bis(2-chloroethyl)ether	3.3 E-04
Bis(chloromethyl)ether	6.2 E-02
Bis(2-ethylhexyl)phthalate	2.4 E-06
Bromoform	1.1 E-06
1,3-butadiene	3.0E-05
Cadmium	1.8 E-03
Captan	1.0E-06
Carbazole	5.7E-06
Carbon Tetrachloride	1.5 E-05
Chlordane	1.0 E-04
Chlorobenzilate	7.8E-05
Chloroform	2.3 E-05
Chloromethane	3.6 E-06
Chromium VI	1.2 E-02
Chrysene	1.1E-05
Cyanazine	2.4E-04
DDE	9.7E-05
Dibenz(a,h)anthracene	1.2E-03
Dibenz(a,h)acridine	1.1E-04
Dibenz(a,j)acridine	1.1E-04
7H-Dibenzo(c,g)carbazole	1.1E-03
Dibenzo(a,e)pyrene	1.1E-03
Dibenzo(a,h)pyrene	1.1E-02
Dibenzo(a,i)pyrene	1.1E-02
Dibenzo(a,l)pyrene	1.1E-02
7,12-Dimethylbenz(a)anthracene	7.1E-02
1,2-dibromo-3-chloropropane	2.0 E-03
1,2-dibromoethane	2.2 E-04
p-Diclorobenzene	1.1E-05
3,3'-Diclorobenzidine	3.4E-04

Contaminant	Unit Risk Factor (m^3/Fg)
1,1-dichloroethane	2.6 E-05
1,2-dichloroethane	2.6 E-05
Dichloroethyl ether	3.3E-04
1,1-dichloroethylene	5.0 E-05
1,3-dichloropropene	4.0 E-06
Dichlorvos	8.3E-05
Dieldrin	4.6 E-03
Diethylstilbestrol	1.4 E-01
Dimethylnitrosamine	1.4 E-02
3,3'-Dimethoxybenzidine	4.0E-06
p-Dimethylaminoazobenzene	1.3E-03
3,3'-Dimethylbenzidine	2.6E-03
1,6-Dinitropyrene	1.1E-02
1,8-Dinitropyrene	1.1E-03
2,4-dinitrotoluene	8.9 E-05
2,4/2,6-Dintrotoluene mixture	1.9E-04
1,4-dioxane	3.1 E-06
1,2-diphenylhydrazine	2.2 E-04
Epichlorohydrin	1.2 E-06
Ethyl acrylate	1.4E-05
Ethyl carbamate	2.9E-04
Ethylene Oxide	8.8E-05
Ethylene Dichloroide	2.6E-05
Ethylene Dibromide	2.2 E-04
Ethylene Thiourea	1.3E-05
Ethylidene Dichloride	1.6E-06
Formaldehyde	1.3 E-05
Heptachlor	1.3 E-03
Heptachlor Epoxide	2.6 E-03
Hexachlorobenzene	4.6 E-04
Hexachlorobutadiene	2.2 E-05
Alpha-hexachloro-cyclohexane	1.8 E-03
Beta-hexachloro-cyclohexane	5.3 E-04
Gamma-hexachloro-cyclohexane	3.8 E-04
Hexachlorocyclohexane, Technical	5.1 E-04
Hexachlorodibenzo-p-dioxin (1,2 mixture)	1.3 E+00
Hexachloroethane	4.0 E-06
Hydrazine	4.9 E-03
Hydrazine Sulfate	4.9 E-03
Indeno(1,2,3-cd)pyrene	1.1E-04
Isophorone	2.7E-07
Lindane	3.1E-04
3-methylcholanthrene	6.3 E-03
5-Methylchrysene	1.1E-03
Methyl Hydrazine	3.1 E-04
Methylene Chloride (dichloromethane)	4.7 E-07
4,4'-methylene-bis-2-chloroaniline	4.3E-04
4,4'-Methylenedianiline	4.6E-04
2-Naphthylamine	3.7E-02
Nickel	2.4 E-04
Nickel Refinery Dust	2.4 E-04

Contaminant	Unit Risk Factor (m^3/Fg)
Nickel Subsulfide	4.8 E-04
5-Nitroacenaphthene	3.7E-05
6-Nitrochrysene	1.1E-02
2-Nitrofluorene	1.1E-05
1-Nitropyrene	1.1E-04
4-Nitropyrene	1.1E-04
2-nitropropane	2.7 E-03
N-nitroso-n-butylamine	1.6 E-03
N-nitroso-n-methylurea	8.6 E-02
N-nitrosodiethylamine	4.3 E-02
Nitrosodimethylamine	1.4E-02
N'-Nitrosomorpholine	1.9E-03
N-nitrosopyrrolidine	6.1 E-04
Pentachloronitrobenzene	7.4 E-05
Pentachorophenol	5.1E-06
PCBs	1.0 E-04
Pronamide	4.6 E-06
1,3-Propane Sultone	6.9E-04
Propylene Dichloride	1.9E-05
Propylene Oxide	3.7E-06
Quinoline	8.6E-04
Reserpine	3.0 E-03
2,3,7,8-tetrachloro-dibenzo-p-dioxin	3.3 E+01
1,1,2,2-tetrachloroethane	5.8 E-05
Tetrachloroethene	5.9E-06
Tetrachloroethylene	5.8 E-07
Thiourea	5.5 E-04
2,4-Toluene Diamine	1.1E-03
2,4/2,6-Toluene diisocyanate mixture (TDI)	1.1E-05
o-Toluidine	5.1E-05
1,1,2-trichloroethane	1.6 E-05
Trichloroethylene	2.0 E-06
2,4,6-trichlorophenol	3.1 E-06
Toxaphene	3.2 E-04
Trifluralin	2.2E-06
Vinyl Chloride	8.8 E-06